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NATIONAL DAM INSPECTION PROGRAM. LAKE HENRY DAM (NDI ID NUMBER --ETC(U)
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SUSQUEHANNA RIVER BASIN

LAKE RUN, LACKAWANNA COUNTY

PENNSYLVANIA

(6) National Dam Inspection Program.

LAKE HENRY DAM

(NDI ID Number PA-00366
DER ID Number 35-16),

~~PENNSYLVANIA GAS AND WATER COMPANY~~,
Susquehanna River Basin, Lake Run,
Lackawanna County, Pennsylvania.

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

Prepared by (10) Albert Charles/Hock.

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
P.O. Box 1963
Harrisburg, Pennsylvania 17105

For

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

(11) APR[redacted]79

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

SUSQUEHANNA RIVER BASIN

LAKE RUN, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE HENRY DAM

NDI ID No. PA-00366
DER ID No. 35-16

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

APRIL 1979

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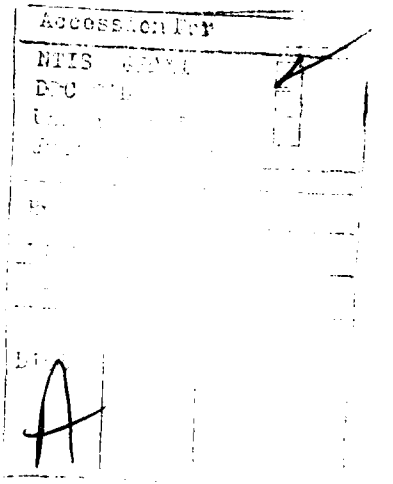

PLATES

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3	Typical Sections.
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C	Hydrology and Hydraulics.
D	Photographs.
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PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Lake Henry NDI ID No. PA-00366/DER ID No. 35-16
Owner:	Pennsylvania Gas and Water Company
State Located:	Pennsylvania
County Located:	Lackawanna
Stream:	Lake Run
Date of Inspection:	27 October 1978
Inspection Team:	Gannett Fleming Corddry and Carpenter, Inc. Consulting Engineers P.O. Box 1963 Harrisburg, Pennsylvania 17105

Based on visual inspection, available records, calculations and past operational performance, Lake Henry Dam is judged to be in good condition. The existing spillway can pass 60 percent of the Probable Maximum Flood (PMF) without overtopping of the dam. The spillway capacity is rated as inadequate.

If the embankments were raised 0.7 foot to their design elevation, the dam could pass the PMF with 0.05 foot of freeboard. The spillway capacity would then be rated as adequate. A low area between the two embankments acts as an auxiliary spillway.

There is no stability analysis for the embankments. There is no evidence of significant problems threatening the embankments. The spillway weir is judged to be stable.

The following measures are recommended to be undertaken by the Owner, in approximate order of priority, without delay.

(1) Raise the embankments to their design elevation.

(2) Extend the riprap on the upstream embankment slopes to the top of the dam. This should be accomplished in a manner to acceptably flatten the upstream slopes.

(3) Grade the low area between the embankments to provide better hydraulic control. Provide erosion protection at the abutments of both embankments.

(4) Fill the hole at the end of the left embankment. Continue to observe the area. If changes are noted, take immediate remedial action.

(5) Remove the brush in the spillway channel and the trees at the toes of the embankment slopes.

(6) Repair the mortar in the spillway walls and the paving in the spillway apron.

(7) Monitor the seepage at the end of the outlet works pipe. The embankment should be inspected for seepage with the pool at spillway crest level. If changes are noted, take appropriate action.

(8) Ensure that a proper size plug is available to provide upstream closure at the outlet works.

(9) Determine if adequate access is available from the right abutment of the right embankment. If it is not, improve the access road.

In addition, it is recommended that the Owner modify his operational procedures as follows:

(1) Develop a detailed emergency operation and warning system for Lake Henry Dam.

(2) Provide round-the-clock surveillance of Lake Henry Dam during periods of un usually heavy rains.

(3) When warnings of a storm of major proportions are given by the National Weather Service, the Owner

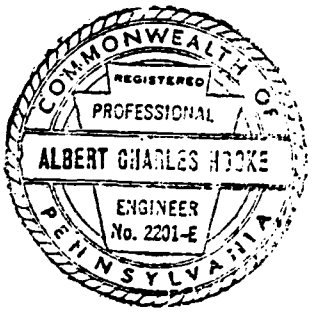
should activate his emergency operation and warning system procedures.

(4) Schedule more frequent visits to observe the condition of the dam.

Submitted by:

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.

A. C. HOOKE
Head, Dam Section



Date: 30 April 1979

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

LAKE HENRY DAM

Overview

SUSQUEHANNA RIVER BASIN

LAKE RUN, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE HENRY DAM

NDI ID No. PA-00366
DER ID No. 35-16
PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

SECTION 1

PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Lake Henry Dam consists of two homogeneous earthfill embankments with masonry core-walls. The embankments are separated by natural ground, the top of which is lower than the top of the embankments. The spillway and outlet works are located in the right embankment. The right embankment is 1,125 feet long and 12 feet high at maximum section. This embankment curves around the lake. The left embankment is 648 feet long and 7 feet high at maximum section. The embankments are separated by a 260-foot length of natural ground, the lowest point of which is 1.8 feet below the design top elevation of the embankments.

The masonry gravity spillway is located at about the center of the right embankment. The crest is 27.2 feet long and it is 2.5 feet below the design top elevation of the dam. The outlet works is about 100 feet to the left of the spillway. It consists of a dry masonry intake structure, a 24-inch diameter cast-iron pipe, and a dry masonry valve pit at the downstream toe of the right embankment. The pipe discharges directly into the stream about 150 feet downstream from the embankment.

b. Location. The dam is located on Lake Run approximately 3.9 miles southeast of Moscow, Pennsylvania. Lake Henry Dam is shown on USGS Quadrangle, Sterling, Pennsylvania, with coordinates N41°17'05" - W75°29'20", in Lackawanna County, Pennsylvania. The dam is 1.9 miles upstream from Hollister Dam, which is breached, and 6.4 miles upstream from Elmhurst Dam. Both Hollister Dam and Elmhurst Dam are on Roaring Brook. The confluence of Lake Run and Roaring Brook is just upstream from Hollister Dam. The location map is shown on Plate 1.

c. Size Classification. Small (12 feet high, 811 acre-feet).

d. Hazard Classification. High hazard. Downstream conditions indicate that a high hazard classification is warranted for Lake Henry Dam (Paragraph 5.1c.).

e. Ownership. Pennsylvania Gas and Water Company, Wilkes-Barre, Pennsylvania.

f. Purpose of Dam. Water supply for Scranton and Dunmore, Pennsylvania.

g. Design and Construction History. Lake Henry was originally a natural lake. Water rights to the lake were acquired by the Owner, under another name, in 1872. Apparently the original Lake Henry Dam was built some years later. In 1895, the two embankments were raised 6.5 feet. The masonry corewalls were apparently built at this time. The raising was apparently designed by William Marple, the Owner's Chief Engineer. The earliest drawings of the dam are dated 1914, when the dam was surveyed at the request of the Pennsylvania Water Supply Commission for their report on the dam. At some later time, the outlet works valve was moved from near the outfall to the downstream toe of the embankment.

1.3 Pertinent Data.

a. Drainage Area. (square miles.)	0.3
b. Discharge at Damsite. (cfs.)	
Maximum known flood at damsite	unknown
Outlet Works at maximum pool elevation (Approximate)	50
Spillway capacity at maximum pool elevation	
Design Conditions:	
Spillway	333
Low area between embankments	379
Total	712
Existing conditions:	
Spillway	204
Low area between embankments	86
Total	290
c. Elevation. (feet above msl.)	
Top of dam (design)	1908.3
Top of dam (existing)	1907.6
Maximum pool	1907.6
Normal pool	1905.8
Natural Lake (approximate)	1891.4
Upstream invert outlet works	1891.4
Downstream invert outlet works	1889.7
Streambed at toe of dam (approximate)	1896.0
d. Reservoir Length. (miles.)	
Normal pool	0.5
Maximum pool	0.5
e. Storage (acre-feet.)	
Natural Lake (approximate)	65
Normal pool	629
Maximum pool (design)	811
f. Reservoir Surface (acres.)	
Natural Lake (approximate)	15.4
Normal pool	69.4
Maximum pool (design)	76.3

g. Dam.

Type (both embankments)	Homogeneous earthfill with masonry core-wall.
Length (feet)	
Right Embankment	1,125
Left Embankment	648
Height (feet)	
Right Embankment	12
Left Embankment	7
Topwidth (feet)	
Right Embankment	Varies, 7 is typical
Left Embankment	4
Side Slopes	
Right Embankment	
Upstream below El. 1905.8	Varies 1V on 3.5H to 1V on 5H
Upstream above El. 1905.8	Near vertical
Downstream	Varies 1V on 2H to 1V on 3H
Left Embankment	
Upstream below El. 1905.8	1V on 5H
Upstream above El. 1905.8	1V on 1H
Downstream	1V on 2.5H
Zoning (both embankments)	None
Cutoff (both embankments)	Core-wall
Grout Curtain	None

h.	Diversion and Regulating Tunnel.	None
i.	Spillway.	
	Type	Masonry gravity weir with inclined top
	Length of Weir. (feet).	27.2
	Crest Elevation	1905.8
	Upstream Channel	Reservoir
	Downstream Channel	Apron 3.8 feet below weir crest. It extends beyond the embankment
	Low Area Between Embankments	See Text
j.	Regulating Outlets.	
	Type	Cast-iron pipe, 24-inch diameter
	Length (feet.)	200
	Closure	24-inch gate valve in valve pit immediately downstream of right embankment
	Access	From right embankment

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. Very little engineering data were available for review. In a study performed in 1914 by the Pennsylvania Water Supply Commission, an account of design concepts, geology, construction materials and methods, and design features was prepared from interviews with the Owner, visual inspection, and other sources. The 1914 study also included analyses for hydrology and hydraulics. A summary of the results of the analyses is on file.

b. Design Features. The dam and appurtenances are described in Paragraph 1.2a. The design features are shown on the Plates at the end of the report and on the Photographs in Appendix D. Plate 2 shows a plan of the dam. The right embankment is shown on Photograph A. The left embankment is shown on Photograph C. A profile of the embankments is shown on Plate 4. Typical sections of the embankments are shown on Plate 3. The spillway is shown on Plate 3 and Photographs E and F. The outlet works is shown on Plate 5 and Photograph B.

There is conflicting data between Plates 2 and 3 and Plates 4 and 5. All are somewhat in conflict with the information gathered during the survey performed for this inspection, as shown in Appendix B. This will be discussed in Sections 5 and 6.

Plates 2 and 3 are dated 1914. It is believed that Plates 4 and 5 were prepared after that date. No design drawings are available.

c. Design Considerations. Almost nothing is known about the design of the dam.

2.2 Construction.

a. Data Available. Construction data available for review for the original structures were limited to information contained in the 1914 Report prepared by the Pennsylvania Water Supply Commission. That information was obtained by interviews with the Owner, and it gives very scant details of the construction operations. The report states that it was impossible to obtain reliable information concerning the construction

of the dam. According to the report, the caretaker stated that the masonry core-wall was founded on a stratified sandstone. No other construction information was cited in the report.

b. Construction Considerations. Since the available information is limited, construction methods cannot be assessed.

2.3 Operation. There are no formal records of operation. Based on information from the Owner and the caretaker of the dam, all structures have performed satisfactorily.

2.4 Evaluation.

a. Availability. Engineering data was provided by the Bureau of Dam Safety, Obstructions, and Storm Water Management, Department of Environmental Resources, Commonwealth of Pennsylvania (PennDER), and by the Owner, Pennsylvania Gas and Water Company. The Owner made available a senior construction supervisor for information during the visual inspection. The Owner also researched his files for additional information upon request of the inspection team.

b. Adequacy. The type and amount of design data and other engineering data is very limited, and the assessment must be based on the combination of available data, visual inspection, performance history, hydrologic assumptions, and hydraulic assumptions.

c. Validity. There is no reason to question the validity of the available data. As noted previously, there is conflicting data, which is discussed hereafter.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. The overall appearance of the dam is fair, with some deficiencies as noted herein. The locations of deficiencies are shown in Appendix B on Plate B-1. Survey data acquired during this inspection is presented in Appendix B. On the day of the inspection, the pool was 5.8 feet below the spillway crest.

b. Embankments. Both embankments are thickly covered by ferns. The caretaker of the dam reported that this was a normal summer's growth. The brush had been cut the previous spring. Trees are growing at the toes of both embankments. The riprap on both embankments only extends up to the spillway crest. The riprap is in good condition. The tops of both embankments have low areas. The low areas extend over most of the tops of both embankments. The lowest point on the right embankment in 0.7 foot below the design top elevation; the lowest point on the left embankment is 0.6 foot below the design top elevation. The existing profiles are shown in Appendix B.

The profile of the natural ground between the embankments is shown in Appendix B. There is a hole, about 3 feet deep and 5 feet in diameter at the right abutment of the left embankment. The hole appeared similar to those left by trees when they are uprooted. No conditions as to what caused the hole were evident.

c. Appurtenant Structures. The outlet works is in good condition. On the day of the inspection, the outlet works valve was operated with no observed deficiencies. The outlet works pipe extends under pressure through the embankment. Clear seepage of 0.5 gpm was observed flowing from under the end of the pipe.

The masonry spillway is in fair condition. The mortar in the spillway walls is somewhat deteriorated. Thick brush is growing in the spillway apron. The stumps remaining from brush cutting are pushing up the paving in areas of the apron.

d. Reservoir Area. The reservoir has generally gentle slopes. The watershed is mostly uninhabited and undeveloped. Some of it is owned and controlled by Pennsylvania Gas and Water Company. There is minor suburban development on the hill by the right abutment of the right embankment.

e. Downstream Channel. The natural channel proceeds for about 1.4 miles through an uninhabited reach to Hollister Reservoir. Hollister Dam belongs to Pennsylvania Gas and Water Company. It is breached. The stream then extends a short distance to a culvert under a railroad embankment. The stream then flows for 2.1 miles to Moscow, which has homes directly adjacent to the low river banks. The stream then flows for 1.4 miles into Elmhurst Reservoir. The access road to the dam extends through a swamp to the left of the dam. On the day of the inspection, it was barely passable by a high ground clearance vehicle.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure. The reservoir is maintained at spillway crest, Elevation 1905.8, with excess inflow discharging over the spillway and into Lake Run, which eventually flows into Elmhurst Reservoir about 5 miles downstream. A 24-inch diameter cast-iron pipe discharges water from the reservoir. Streamflows in Lake Run can be increased by releases from Lake Henry Dam. Since streamflow is usually augmented only when Elmhurst Reservoir is below spillway crest elevation, the valve on the Lake Henry water discharge line is usually closed.
The Owner, while responsible for the dam, does not have water rights for the entire storage. He can only utilize the upper portion of the stored water.

4.2 Maintenance of Dam. The dam is visited monthly, except during the winter, by a caretaker who records the reservoir elevation. The dam is not visited during the winter. Reports are mailed to the Owner's Engineering Department. This information is used by the Owner's Engineering Department for regulating flows in the distribution system. The caretaker is also responsible for observing the general condition of the dam and appurtenant structures and for reporting any changes or deficiencies to the Owner's Engineering Department. A Pennsylvania Gas and Water Company engineer makes a formal inspection of the dam each year, and the records are filed and used for determining the priority of repairs. Informal inspections are also made when the engineer is on the site for other reasons. Brush on the embankments is cut annually.

4.3 Maintenance of Operating Facilities. The valve on the outlet works pipe is operated infrequently. In response to the Phase I Dam Inspection Program of the previous year, the Owner is revising his maintenance procedures. Details of the procedures are still being developed.

4.4 Warning Systems in Effect. The Owner furnished the inspection team with a verbal description of the chain of command for Lake Henry Dam and of a generalized emergency notification list that is applicable for all of the Pennsylvania Gas and Water Company dams. The Owner said that during periods of heavy rainfall,

available personnel are dispatched to the dams to observe conditions. All company vehicles are equipped with radios, and the personnel can communicate with each other and with a central control facility. Evaluation of risk is made by the Owner's Engineering Department. The Owner's Engineering Department is also responsible for notification of emergency conditions to the local authorities. Detailed emergency operational procedures have not been formally established for Lake Henry Dam, but are as directed by the Owner's Engineering Department.

4.5 Evaluation of Operational Adequacy. Maintenance of the dam, except for the brush in the spillway outlet channel, appears good. Although the outlet works valve operated adequately, the maintenance procedures for the valve could be improved. More frequent visits to observe the conditions at the dam, especially in the winters, appear to be warranted. The procedures used by the Owner for inspecting the dam are adequate, but some needed repairs have not been made. In general, the warning system is adequate, but it would be more effective if it were more detailed.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. In their 1914 Report, the Pennsylvania Water Supply Commission estimated the design spillway capacity at 225 cfs. This was estimated using a 1.9 foot maximum head. It was also estimated using a 28.3-foot crest length, as discussed hereafter. A design spillway capacity of 333 cfs is used for this study (Appendix C). Additional spillway capacity is available at the low area that separates the embankments, as is discussed hereafter.

b. Experience Data. The Owner did not report any hydraulic problems with the dam. He does not have any information concerning flows during times of flood.

c. Visual Observations.

(1) General. The visual inspection of Lake Henry Dam, which is described in Section 3, resulted in a number of observations relevant to hydraulics and hydrology. These observations are evaluated herein for the various features.

(2) Embankments. The low areas at the top of the embankments reduce the spillway discharge capacity. The low area of natural ground between the embankments will convey outflow before the embankments are overtopped. This may cause some erosion at the abutments of the embankments, and it is considered an erosion hazard. However, it is not felt that it would cause failure of the dam. Since the area acts as an auxiliary spillway, grading the area, clearing it of the minor amount of brush present, and protecting the ends of the embankments would appear to be warranted.

There is some concern that this condition was never officially reported during the previous inspections by the Commonwealth. The condition was very noticeable on the day of the inspection.

(3) Appurtenant Structures. Except for the pipe extending under pressure through the embankment, no deficiencies were observed at the outlet works. The Owner stated that various size plugs and an in-house diving capability are available to provide

upstream closure. This is deemed adequate, if the correct size plug is readily available.

The brush in the spillway apron will raise tailwater. It is estimated that this will not reduce the spillway discharge capacity. However, it provides a greater erosion potential at the embankment. The stumps, which push-up the apron paving, are creating an erosion hazard. Previous reports, as well as Plate 3, indicate that the spillway crest length is 28.3 feet. A crest length of 27.2 feet was measured for this inspection and is used in this study. The reasons for the variation are unknown.

(4) Reservoir Area. No conditions were observed in the reservoir area or watershed that might present significant hazard to the dam. The records state that the drainage area at the site is 0.9 square mile. This estimate was from 1914, or earlier, and never updated. Using more recent USGS mapping, the drainage area measures to be 0.3 square mile, which is used in this study. The assessment of the dam is based on existing conditions, and the effects of future development are not considered.

(5) Downstream Conditions. No conditions were observed immediately downstream from the dam that would create significant hazard to the dam. If the dam should fail, a hazard to at least 12 dwellings in Moscow would exist. Hollister Dam and the railroad culvert immediately downstream of it could provide significant mitigating effects to floodflows from Lake Henry Dam. In addition, the floodflows would discharge into Elmhurst Reservoir. A Phase I Inspection Report for the National Dam Inspection Program has previously been prepared for Elmhurst Dam, which is of intermediate size. Elmhurst Dam was classified as high hazard, with an inadequate spillway. It is not felt that the failure of Lake Henry Dam would pose a significant threat to Elmhurst Dam. Because of the possibility of flooding dwellings in Moscow, a high hazard classification is warranted for Lake Henry Dam. Access to Lake Henry Dam is poor. There is an alternate access route to the dam through the development near the right abutment of the right embankment. The Owner does not use this route, the last 300 feet of which is not traversable by vehicle.

d. Overtopping Potential.

(1) Spillway Design Flood. According to the criteria established by the Office of the Chief

of Engineers (OCE) for the size (Small) and hazard potential (High) of Lake Henry Dam, the spillway design flood (SDF) varies between the probable maximum flood (PMF) and the 1/2 PMF. The PMF is selected as the SDF because of the number of dwellings that could be flooded in Moscow.

(2) Description of Model. The watershed was modeled with the HEC-1DB computer program. The HEC-1DB computer program computes a PMF runoff hydrograph and routes the flows through both reservoirs and stream sections. In addition, it has the capability to simulate an overtopping dam failure. The PMF inflow to Lake Henry was determined and routed through the dam. Identical methods were used for various percentages of the PMF.

(3) Summary of Results. Pertinent results are tabularized at the end of Appendix C. The analysis reveals that Lake Henry Dam, with its existing top elevation of 1907.6 can pass approximately 60 percent of the PMF without overtopping.

If Lake Henry Dam were raised to its design elevation of 1908.3, it would be able to pass the PMF with 0.05 foot of freeboard remaining.

(4) Spillway Adequacy. The criteria used to rate the spillway adequacy of a dam are described in Appendix C. Since Lake Henry Dam cannot pass the PMF but can pass the 1/2 PMF, the spillway capacity is rated as inadequate. If the dam were raised to its design elevation, the spillway would be rated as adequate.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of Lake Henry Dam, which is described in Section 3, resulted in a number of observations relevant to structural stability. These observations are evaluated herein for various features.

(2) Embankments. The brush on the embankments is sufficiently small that it presents no hazard to the embankment. It did hinder the visual inspection. Trees at the toes of the slopes are undesirable. The riprap not extending to top of dam is an erosion hazard.

Reference is made to Plates 3 and 5, and the cross-sections in Appendix B. The cross-sections show conflicting slopes. The reason for this is unknown. The slopes listed in the pertinent data were taken from Appendix B. The design top elevation of the dam is taken from Plate 3. The height of the right embankment is taken from Plate 5. There is no concern about the existing slopes of the embankment except for the upper 2 feet of the upstream slope, which is 1V on 1H at the flattest and near-vertical at places. As noted above, this slope is unprotected.

The low areas at the tops of the embankments are probably caused by settlement. Low areas were noted in some of the periodic inspections by the Commonwealth. The low area between the embankments is evaluated in Section 5.

The cause of the hole at the right end of the left embankment is unknown. There is no evidence of conditions hazardous to the dam. However, it could be an indication of more serious problems.

Observations concerning seepage through the embankment were not definitive because of the low pool on the day of inspection. No seepage or wet areas were observed near the embankment on the day of the inspection.

(3) Appurtenant Structures. The end of the outlet works pipe is 150 feet downstream from the embankment. The seepage observed at the end of the pipe is not excessive. It could be caused by either the natural ground water levels or by a leak in the pipe joints. Because the pool was low, the observed seepage was probably lower than that which would occur during normal pool conditions.

The deteriorated mortar in the spillway is an indication of the lack of maintenance.

b. Design and Construction Data. There is no stability analysis for the embankment. There is no evidence of significant problems that presently threaten the embankment. It is judged that the spillway section that is shown on Plate 3 should be stable under the maximum loading condition. Stability analysis is not usually performed on a structure of this height.

c. Operating Records. There are no formal records of operation. According to the Owner, no stability problems have occurred over the operational history of the dam.

d. Postconstruction Changes. As noted herein, there is sufficient information available on all modifications made to Lake Henry Dam, such that its stability can be assessed.

e. Seismic Stability. Lake Henry Dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone has adequate factors of safety under static loading conditions, it can be assumed safe for any expected earthquake loading. However, since there are no formal stability analyses and since there is the possibility of earthquake forces cracking the masonry core-wall, the theoretical seismic stability of Lake Henry Dam is not known.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND

PROPOSED REMEDIAL MEASURES.

7.1 Dam Assessment.

a. Safety.

(1) Based on visual inspection, available records, calculations, and past operational performance, Lake Henry Dam is judged to be in good condition. With existing conditions, the spillway can pass 60 percent of the PMF without overtopping of the dam. The spillway capacity is rated as inadequate. If the Dam were raised to its design elevation, it could pass the PMF with 0.05 foot of freeboard. The spillway capacity would then be rated as adequate. A low area between the embankments acts as an auxiliary spillway.

(2) There is no stability analysis for the embankment. There is no evidence of significant problems threatening the embankment. The spillway weir is judged to be stable.

(3) The visual inspection revealed some deficiencies, which are summarized below for the various features.

Feature and Location	Observed Deficiencies
Embankments:	
Toes	Trees
Upstream slope	Steep upper slope without riprap
Right end of left embankment	Hole
Top	Low areas
Spillway:	
Walls	Deteriorated mortar
Apron	Brush, dislodged paving
Outlet Works:	
	Uncertain upstream closure facilities, seepage at end.

Feature and Location	Observed Deficiencies
Access:	Access road in poor condition.

b. Adequacy of Information. The information available is such that an assessment of the condition of the dam can be inferred from the combination of visual inspection, past performance, and computations performed prior to and as part of this study.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented without delay.

d. Necessity for Further Investigations. Accomplishment of the remedial measures outlined in Paragraph 7.2, do not require further investigations by the Owner.

7.2 Recommendations and Remedial Measures.

a. The following measures are recommended to be undertaken by the Owner, in approximate order of priority, as soon as practical:

(1) Raise the embankments to their design elevation.

(2) Extend the riprap on the upstream embankment slopes to the top of the dam. This should be accomplished in a manner to acceptably flatten the upstream slopes.

(3) Grade the low area between the embankments to provide better hydraulic control. Provide erosion protection at the abutments of both embankments.

(4) Fill the hole at the end of the left embankment. Continue to observe the area. If changes are noted, take immediate remedial action.

(5) Remove the brush in the spillway channel and the trees at the toes of the embankment slopes.

(6) Repair the mortar in the spillway walls and the paving in the spillway apron.

(7) Monitor the seepage at the end of the outlet works pipe. The embankment should be inspected for seepage with the pool at spillway crest level. If changes are noted, take appropriate action.

(8) Ensure that a proper size plug is available to provide upstream closure at the outlet works.

(9) Determine if adequate access is available from the right abutment of the right embankment. If it is not, improve the access road.

b. In addition, it is recommended that the Owner modify his operational procedures as follows:

(1) Develop a detailed emergency operation and warning system for Lake Henry Dam.

(2) Provide round-the-clock surveillance of Lake Henry Dam during periods of unusually heavy rains.

(3) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system procedures.

(4) Schedule more frequent visits to observe the condition of the dam.

SUSQUEHANNA RIVER BASIN

LAKE RUN, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE HENRY DAM

NDI ID No. PA-00366
DER ID No. 35-16

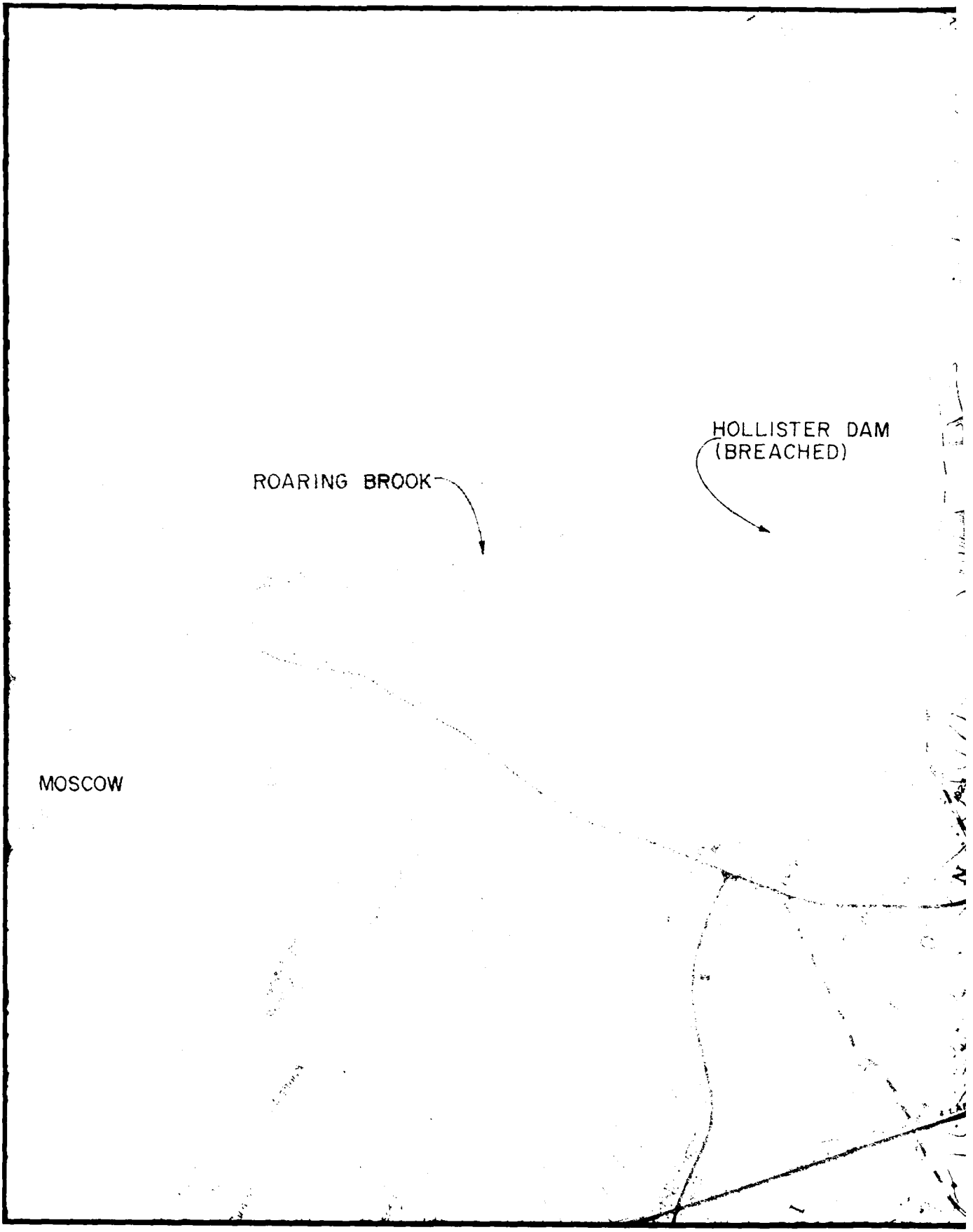
PENNSYLVANIA GAS AND WATER COMPANY

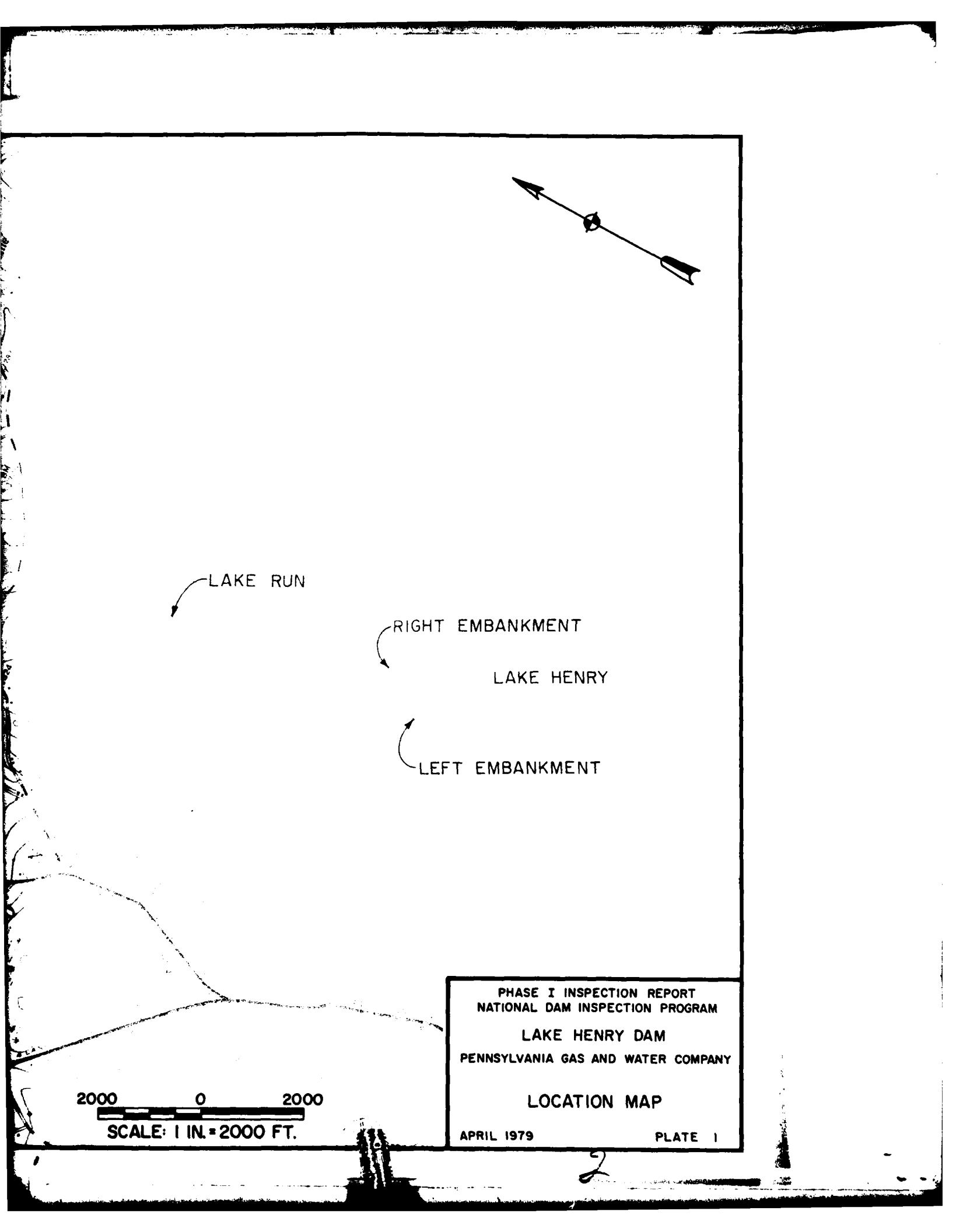
PHASE I INSPECTION REPORT

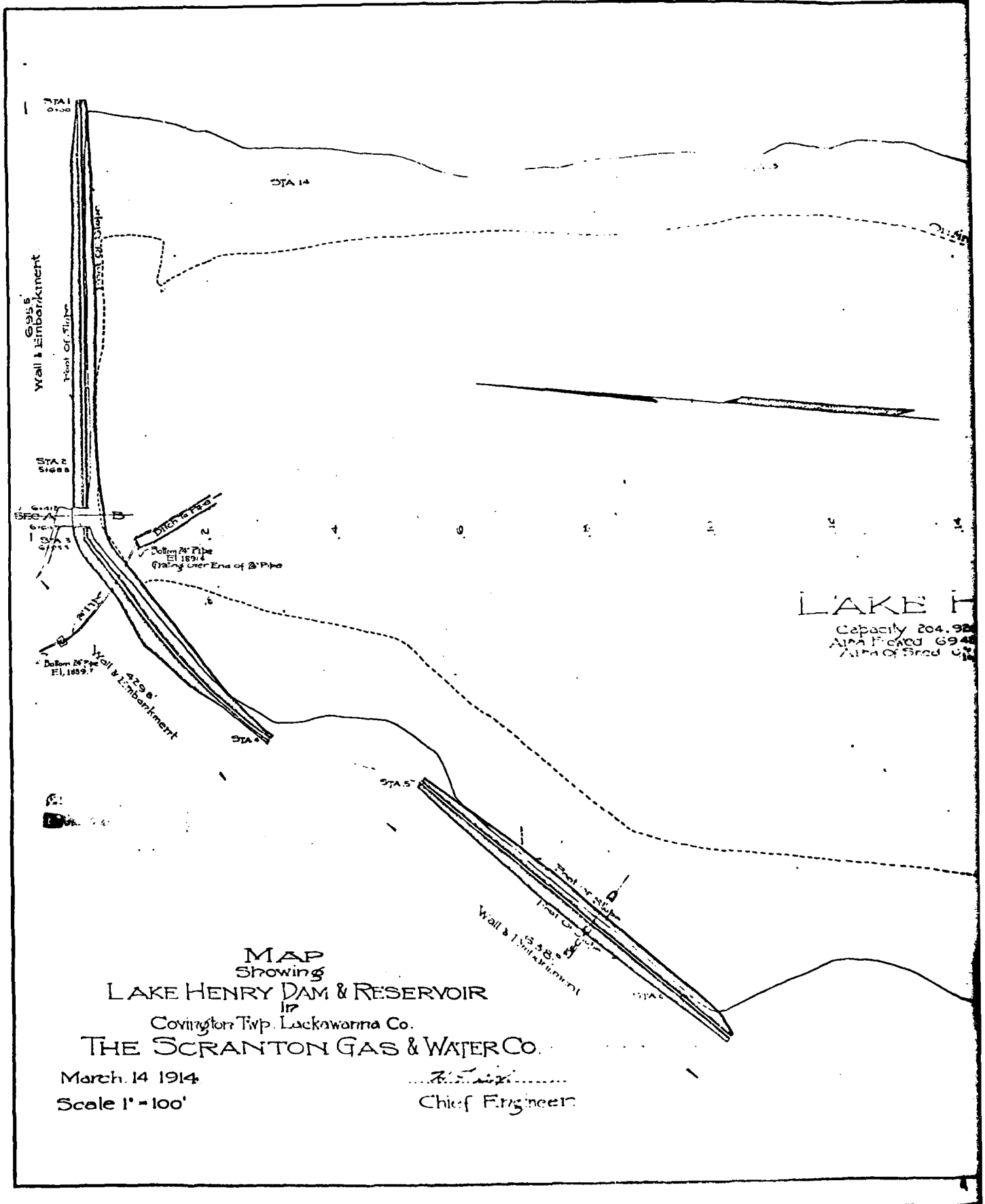
NATIONAL DAM INSPECTION PROGRAM

APRIL 1979

PLATES


HOLLISTER DAM
(BREACHED)
ROARING BROOK
MOSCOW


LAKE RUN
RIGHT EMBANKMENT
LAKE HENRY
LEFT EMBANKMENT
2000 0 2000
SCALE: 1 IN. = 2000 FT.
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
LAKE HENRY DAM
PENNSYLVANIA GAS AND WATER COMPANY
LOCATION MAP
APRIL 1979
PLATE 1

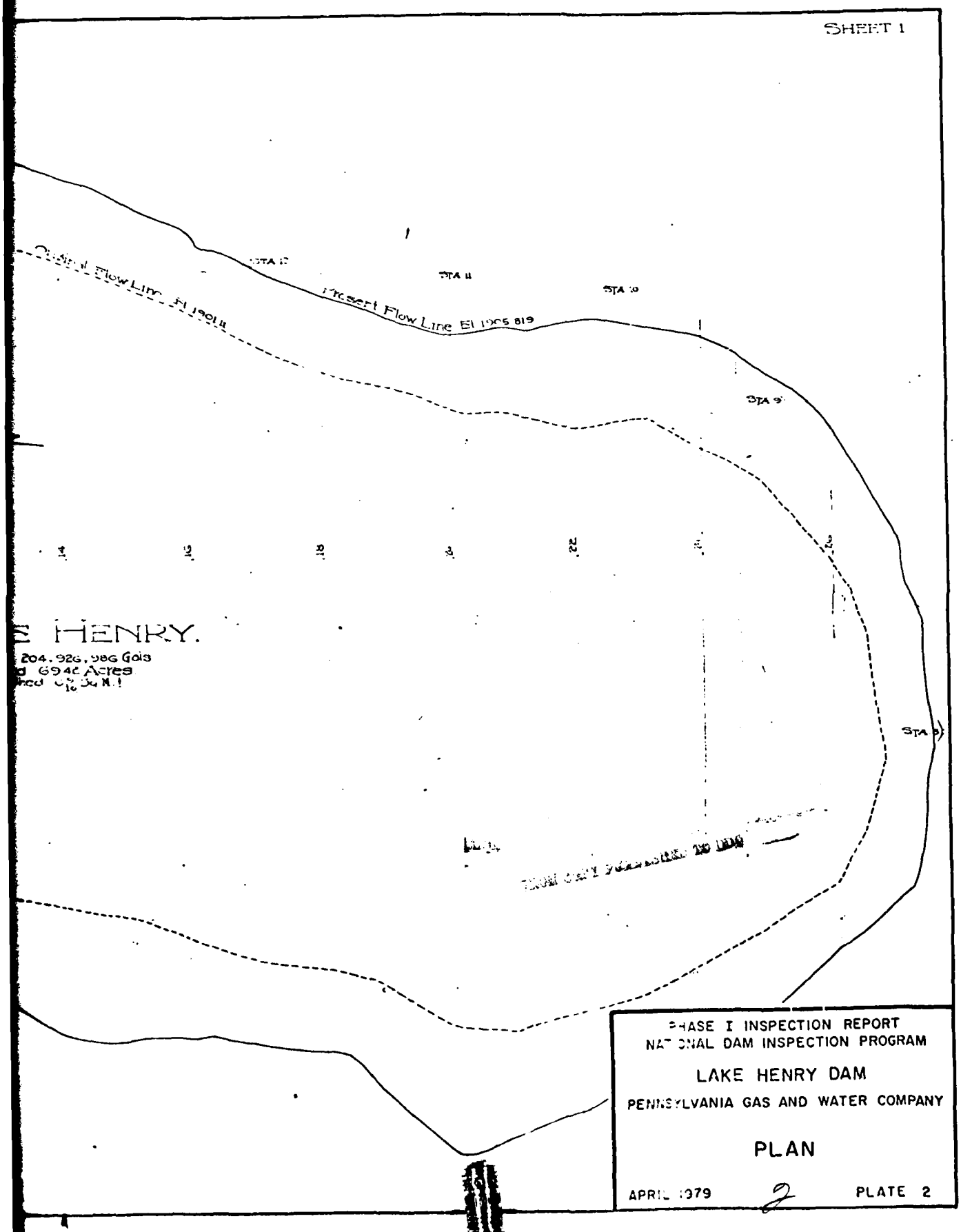


MAP
Showing
LAKE HENRY DAM & RESERVOIR
In
Covington Twp. Lackawanna Co.
THE SCRANTON GAS & WATER CO.

March. 14 1914

Scale 1" = 100'

.....
Chief Engineer



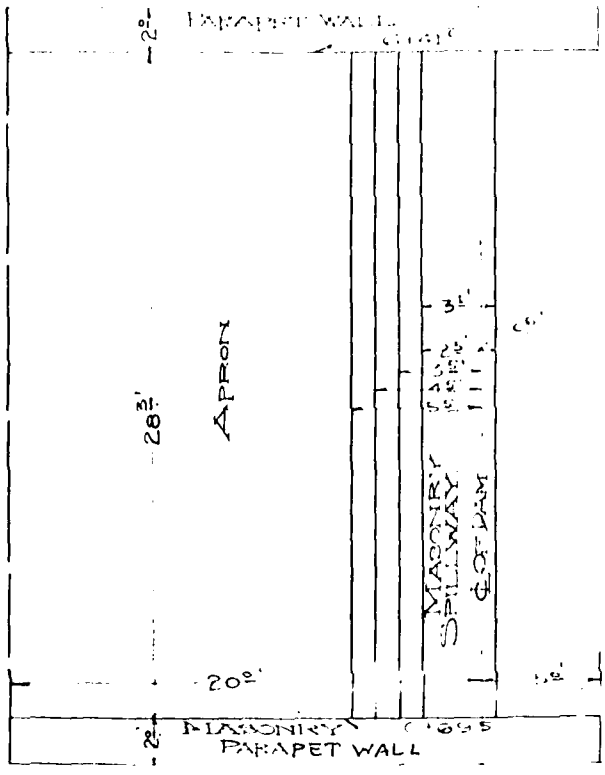
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE HENRY DAM

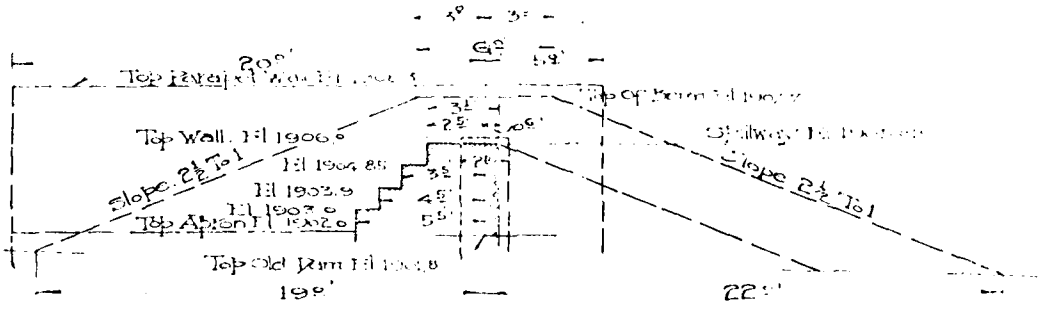
PENNSYLVANIA GAS AND WATER COMPANY

PLAN

APRIL 1979 PLATE 2

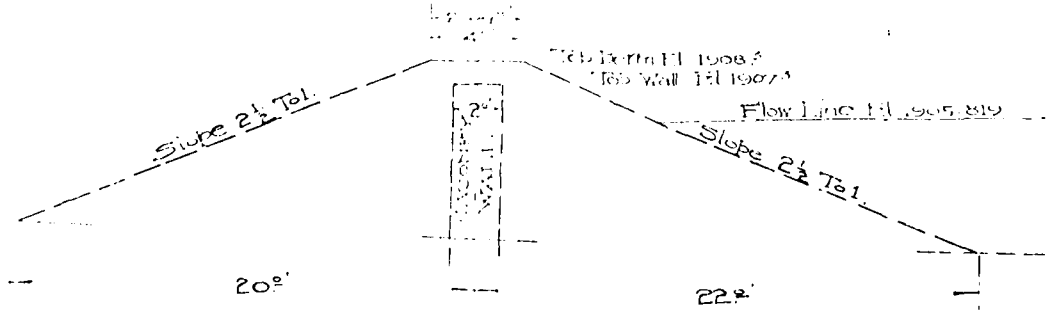


PLAN OF SPILLWAY
SCALE 1"=4'



SECTION A-B.
Through Spillway
Scale 1"=4'

			3	
			9	2 104
			9	71
			108	
				55 123
			111	19
			114	19 71
			115	1- 13
			191	107



SECTION C-D.
Scale 1"=4'

PHASE I INSPECTION
NATIONAL DAM INSPECTIO

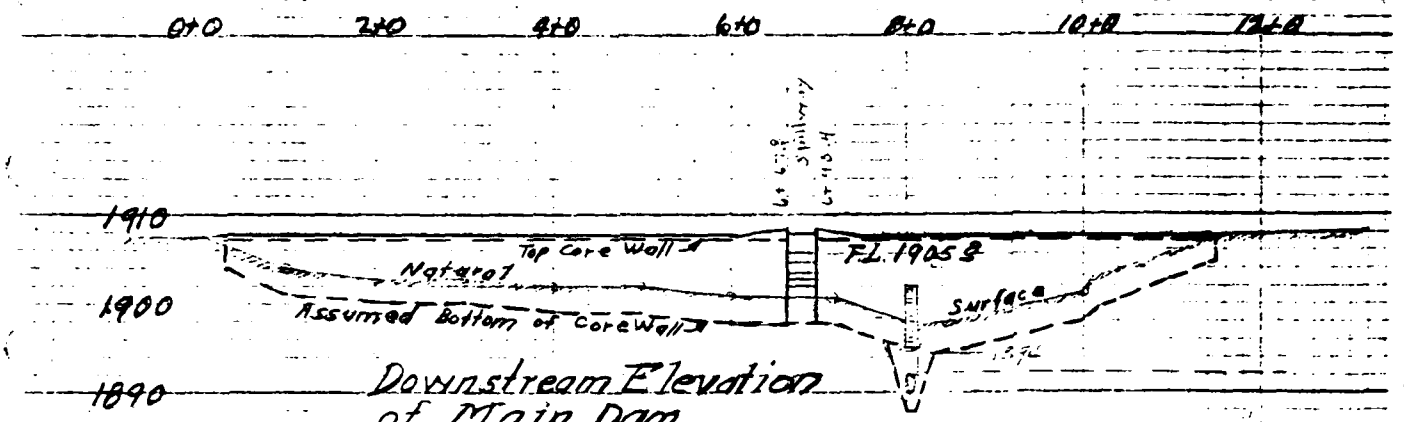
LAKE HENRY D

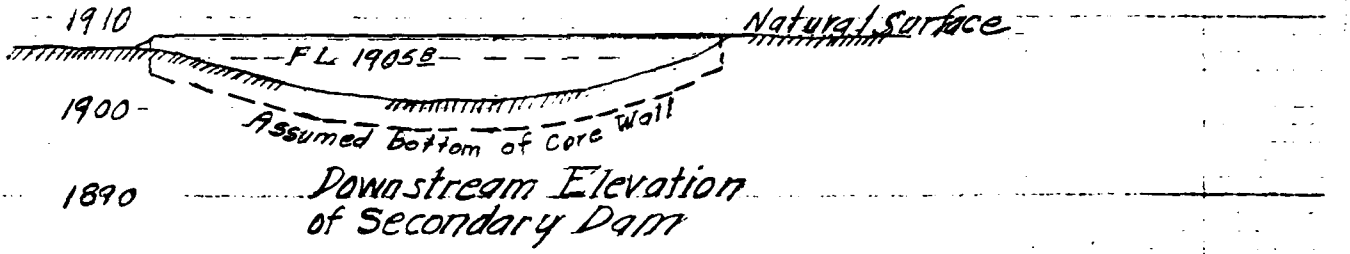
PENNSYLVANIA GAS AND WA

TYPICAL SECTI

APRIL 1979

S. G. & W. C.
Supply Dam
Sheet 15





ELEVATIONS OF 2-DMS

Scales: Vert: 1" = 20'
Horiz: 1" = 200'

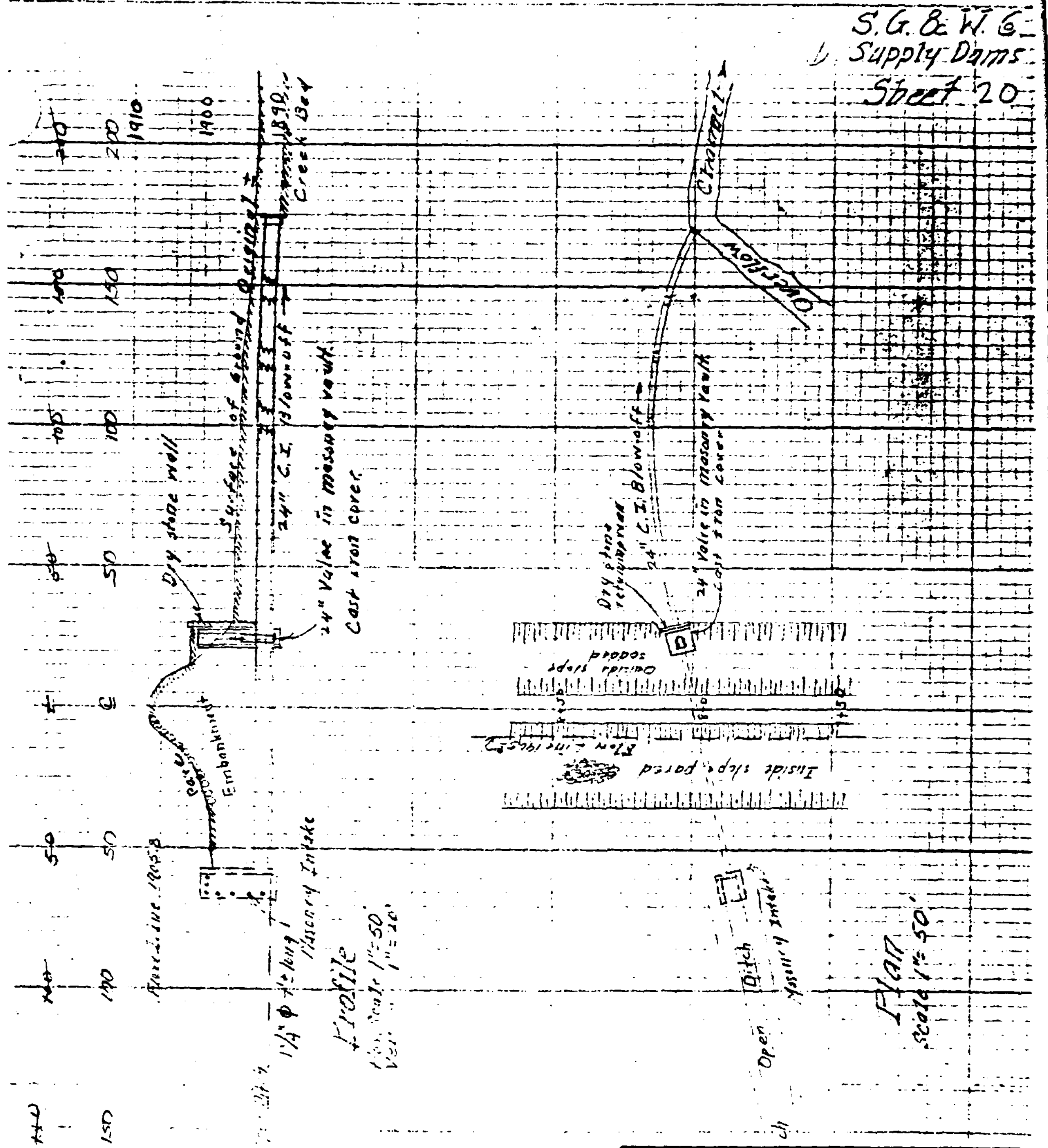
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE HENRY DAM

PENNSYLVANIA GAS AND WATER COMPANY

PROFILES

APRIL 1979 PLATE 4



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE HENRY DAM

PENNSYLVANIA GAS AND WATER COMPANY

OUTLET WORKS

APRIL 1979 PLATE 5

SUSQUEHANNA RIVER BASIN

LAKE RUN, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE HENRY DAM

NDI ID No. PA-00366
DER ID No. 35-16

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

APRIL 1979

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: LAKE HENRY

NDI ID NO.: PA-00366 DER ID NO.: 35-16

Sheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	SEE PLATES 2-5 NOT "AS-BUILT" - PREPARED FOR 1914 REPORT AND MODIFICATIONS
REGIONAL VICINITY MAP	SEE PLATE 1
CONSTRUCTION HISTORY	BUILT AT UNCERTAIN DATE RAISED IN 1895 OR 1896
TYPICAL SECTIONS OF DAM	SEE PLATE 3
OUTLETS: Plan Details Constraints Discharge Ratings	SEE PLATE 2

A-1

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	NONE
DESIGN REPORTS	NONE
GEOLOGY REPORTS	1914 PENNSYLVANIA WATER SUPPLY COMMISSION REPORT
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	IN 1914 REPORT by PENNSYLVANIA WATER SUPPLY COMMISSION - HYDRAULICS AND HYDROLOGY
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	NONE
POSTCONSTRUCTION SURVEYS OF DAM	SEE PLATES 2-5

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	NOT AVAILABLE
MONITORING SYSTEMS	NONE
MODIFICATIONS	SEE CONSTRUCTION HISTORY
HIGH POOL RECORDS	NONE
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	NONE
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	NONE

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	NOT AVAILABLE
SPILLWAY: Plan Sections Details	SEE PLATE 3
OPERATING EQUIPMENT: Plans Details	SEE PLATE 2
PREVIOUS INSPECTIONS Dates Deficiencies	1920 - TOP OF DAM LOW AND UNEVEN, ESPECIALLY TO THE RIGHT OF THE SPILLWAY. THE SPILLWAY NEEDS POINTING AND BRUSH IS GROWING IN IT. BRUSH AND TREES ON THE EMBANKMENT. ORDERED REPAIRED PER 1914 REPORT. 1921 - PER 1920 AND ALSO MASONRY AT OUTLET COLLAPSED. REPAIRS ORDERED
	1921 - ALL ITEMS ABOVE REPAIRED EXCEPT BRUSH CUT NOT COMPLETE. 1924 - GROUND SEPARATING EMBANKMENTS IS LOWER THAN TOP OF EMBANKMENTS. SEEPAGE TO RIGHT OF SPILLWAY.

4-4

ENGINEERING DATA

ITEM	REMARKS
PREVIOUS INSPECTIONS (CONTINUED)	1928 - GROUND DOWNSTREAM OF EMBANKMENT TO RIGHT OF EMBANKMENT IS SWAMPY. 1932 - GROUND DOWNSTREAM OF TOE IS SWAMPY. LEFT EMBANKMENT IS COVERED WITH BRUSH.
	1937 - TOP OF DAM IS UNEVEN, DOWNSTREAM TOE IS SWAMPY IN SPOTS TO THE LEFT OF THE SPILLWAY AND CONTINUOUSLY SWAMPY TO THE RIGHT.
	1941 - TOP OF DAM IS UNEVEN. "JOINTS HAVE STARTED TO OPEN IN THE MASONRY AT DOWNSTREAM FACE OF SPILLWAY SECTION." SLIGHT SEEPAGE AT LOWER END OF BLOWOFF; TOE TO RIGHT OF SPILLWAY
	IS SWAMPY. "JOINTS OF MASONRY HAVE STARTED TO OPEN IN SPILLWAY ABUTMENT WALLS." BRUSH IN SPILLWAY CHANNEL 1945 - PER 1941. 1953 - TOP OF DAM IS SLIGHTLY UNEVEN.
	SPILLWAY ABUTMENTS NEED REPOINTING. SMALL AMOUNT OF SEEPAGE ALONG RIGHT TOE. BRUSH ON EMBANKMENT.

A-5

SUSQUEHANNA RIVER BASIN

LAKE RUN, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE HENRY DAM

NDI ID No. PA-00366
DER ID No. 35-16

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

APRIL 1979

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: LAKE HENRY County: LACKAWANNA State: PENNSYLVANIA

NDI ID No.: PA-00366 DER ID No.: 35-16

Type of Dam: EARTHFILL W/ MASONRY CORE-WALL Hazard Category: HIGH

Date(s) Inspection: OCTOBER 27, 1978 Weather: CLOUDY Temperature: 55°F

SOIL CONDITIONS: VERY MOIST

Pool Elevation at Time of Inspection: 1900.0 msl/Tailwater at Time of Inspection: NONE msl

Inspection Personnel:

D. WOLF (GFCC) R. GLOCKNER (PGW)

D. EBERSOLE (GFCC)

J. BORDNAR (PGW)

A. WHITMAN (GFCC) Recorder

8-7

EMBANKMENT

Sheet 1 of 2

RIGHT EMBANKMENT LEFT EMBANKMENT

VISUAL EXAMINATION OF	~~OBSERVATIONS~~	~~REMARKS OR RECOMMENDATIONS~~
SURFACE CRACKS	NONE	NONE
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	NONE	HOLE TO RIGHT OF LEFT EMBANKMENT
SLOUGHING OR EROSION: Embankment Slopes Abutment Slopes	NONE	NONE
CREST ALIGNMENT: Vertical Horizontal	SEE SURVEY DATA FOLLOWING INSPECTION FORMS.	SEE RIGHT EMBANKMENT
RIPRAP FAILURES	SEE SURVEY DATA RIPRAP DOES NOT EXTEND TO THE TOP OF THE DAM ON BOTH EMBANKMENTS.	OTHERWISE, IN GOOD CONDITION.

B-2

EMBANKMENT

Sheet 2 of 2

VISUAL EXAMINATION OF	RIGHT EMBANKMENT ~~OBSERVATIONS~~	LEFT EMBANKMENT ~~REMARKS OR RECOMMENDATIONS~~
JUNCTION OF EMBANKMENT WITH: Abutment Spillway Other Features	AREA SEPARATING THE EMBANKMENTS IS LOW, SEE SURVEY DATA.	SEE RIGHT EMBANKMENT.
ANY NOTICEABLE SEEPAGE	NONE	NONE
STAFF GAGE AND RECORDER	NONE	NONE
DRAINS	NONE	NONE
BRUSH	2' HIGH FERNS COVER THE TOP AND DOWN-STREAM SLOPES OF BOTH EMBANKMENTS.	TREES ARE GROWING ALONG BOTH DOWNSTREAM TOES.

B-3

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	24" CIP NO OBSERVED DEFICIENCIES	
INTAKE STRUCTURE	DRY MASONRY - SOMEWHAT IRREGULAR IN SHAPE.	NO DEFICIENCIES.
OUTLET STRUCTURE	PIPE OUTLETS DIRECTLY TO STREAM.	SEEPAGE OF 0.5 gpm AT OUTLET, WHICH IS 150 FEET FROM EMBANKMENT
OUTLET CHANNEL	NO DEFICIENCIES	
EMERGENCY GATE	OPERATED WITH NO DIFFICULTY.	

UNGATED SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MASONRY ~~CONCRETE~~ WEIR	WEIR IS COVERED WITH CONCRETE. NO DEFICIENCY.	
APPROACH CHANNEL	RESERVOIR	
DISCHARGE CHANNEL	THICK BRUSH IN APRON AREA; STUMPS ARE PUSHING UP PAVING.	MORTAR IN WALLS IS SOMEWHAT DETERIORATED.
BRIDGE AND PIERS	N/A	

5-8

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	NONE	
OBSERVATION WELLS	NONE	
WEIRS	NONE	
PIEZOMETERS	NONE	
OTHER	NONE	

RESERVOIR AND WATERSHED

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	GENERALLY MILD	
SEDIMENTATION	NO OBSERVED OR REPORTED PROBLEMS.	
WATERSHED DESCRIPTION	WOODED. MINOR SUBURBAN DEVELOPMENT IN A SMALL PART.	

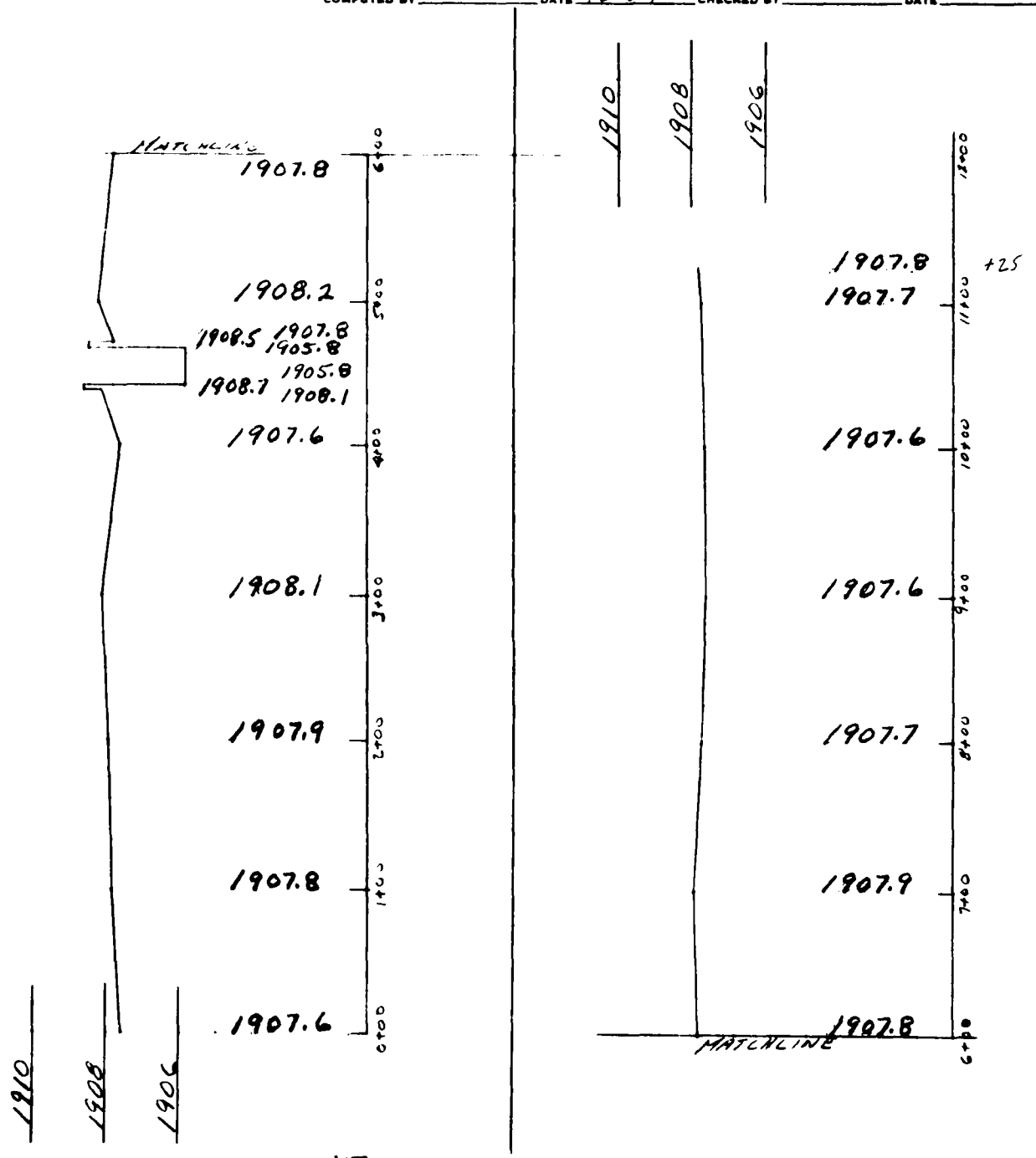
DOWNSTREAM CHANNEL

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: Obstructions Debris Other	NONE, CHANNEL FLOWS THROUGH A SWAMP	
SLOPES	GENERALLY MILD	
APPROXIMATE NUMBER OF HOMES AND POPULATION	TOWN OF MOSCOW, MANY HOMES ON LOW BANKS OF STREAM.	HOLLISTER DAM (BREACHED) BETWEEN MOSCOW AND LAKE HENRY.

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT Flood Control Dam — FILE NO. 1952
Pleasant Grove Embankment — SHEET NO. ____ OF ____ SHEETS
FOR
COMPUTED BY DRC DATE 12-3-70 CHECKED BY ____ DATE ____



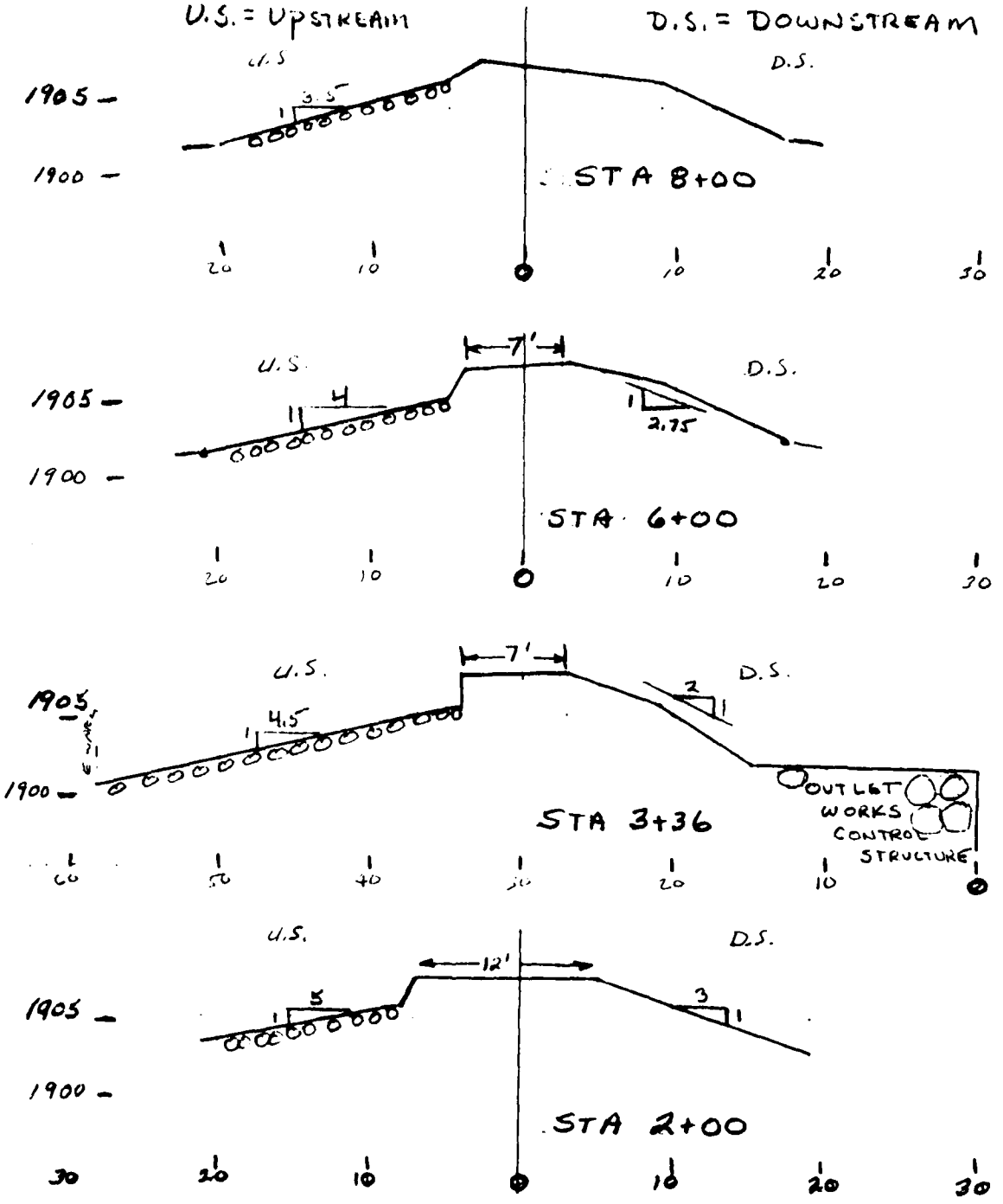
KIGHT EMBANKMENT - PROFILE

B-9

6915

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT LAKE HONEY DAM — FILE NO. 7852
SECTIONS - MAIN EMBANKMENT — SHEET NO. ____ OF ____ SHEETS
FOR
COMPUTED BY DLC — DATE 12-8-78 — CHECKED BY ____ — DATE ____



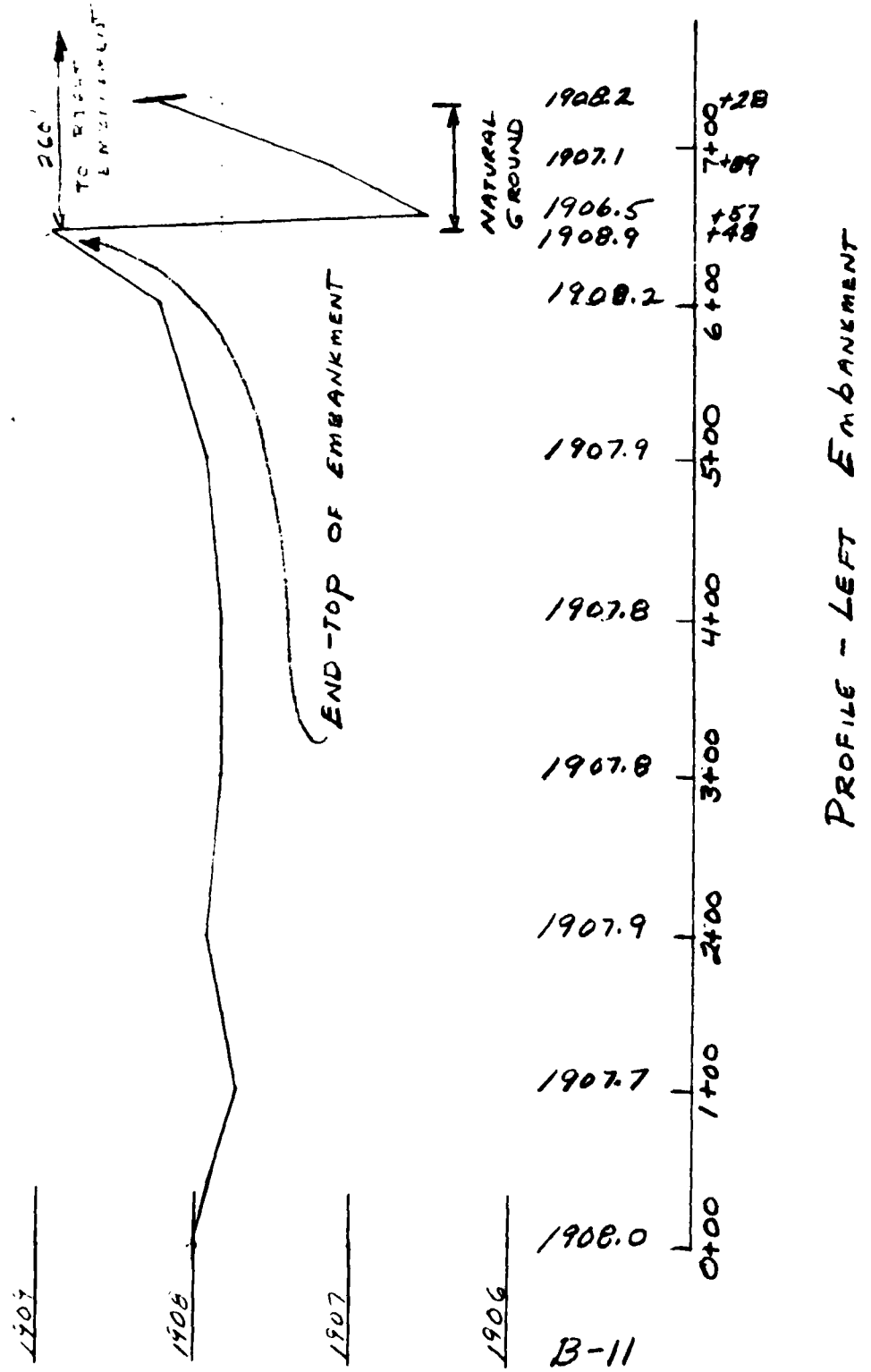
RIGHT EMBANKMENT - SECTIONS

B-10

8513

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT U.S. HENRY DAM — FILE NO. 7832
PROFILE AUX. EMBANKMENT — SHEET NO. ____ OF ____ SHEETS
FOR ____
COMPUTED BY DKE — DATE 12-11-78 — CHECKED BY ____ — DATE ____

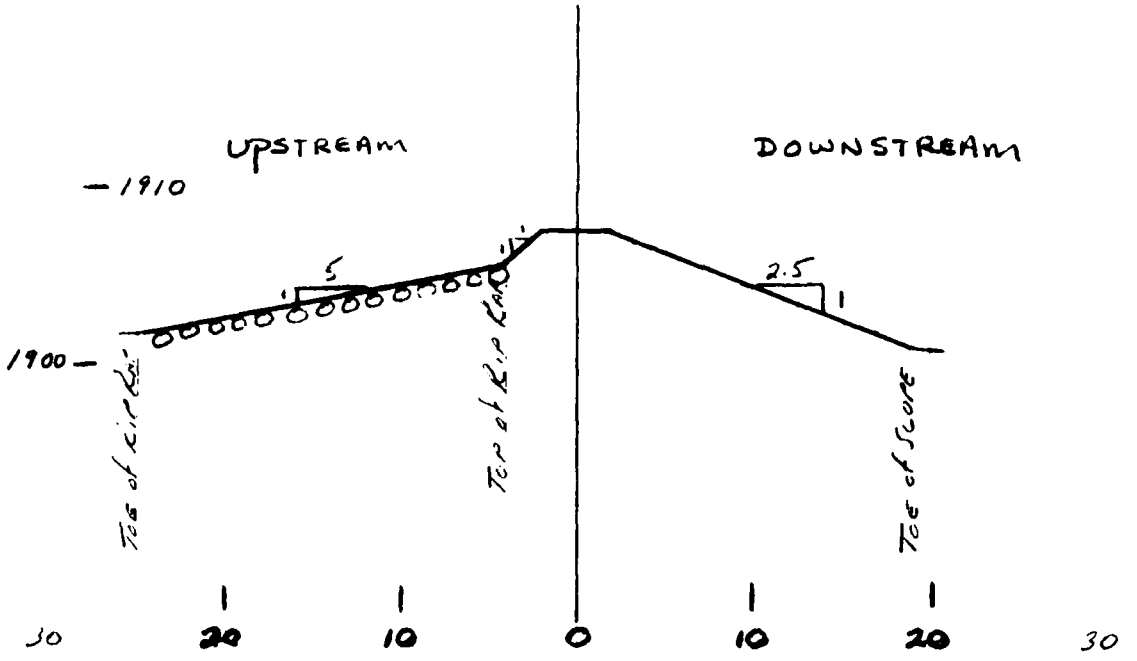


B-11

8513

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

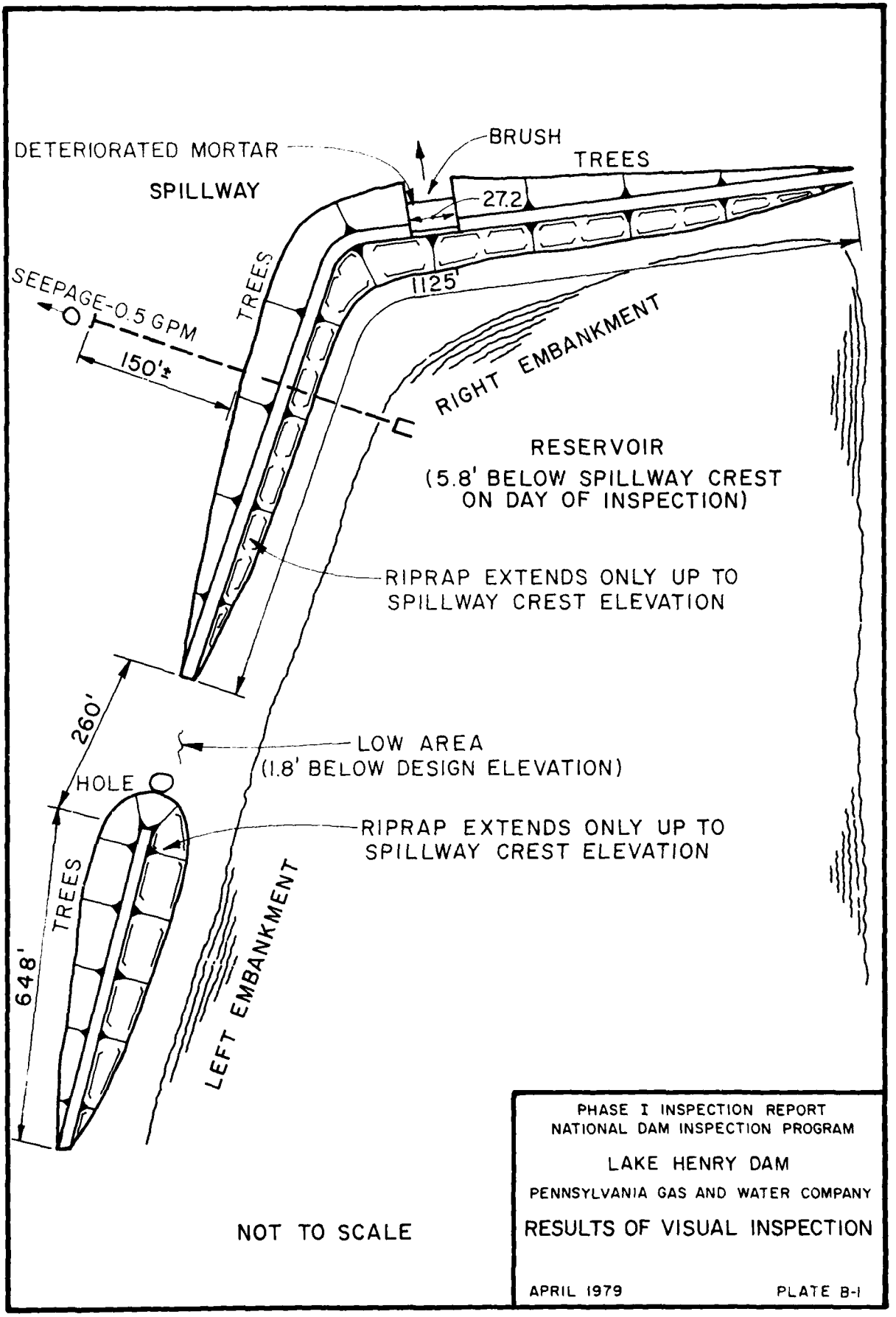
SUBJECT Dam Check Dam FILE NO. 1912
SECTION - DUX EMBANKMENT SHEET NO. ____ OF ____ SHEETS
FOR ____
COMPUTED BY DLC DATE 12-11-78 CHECKED BY ____ DATE ____



LEFT EMBANKMENT - SECTION

B-12

8313



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE HENRY DAM

PENNSYLVANIA GAS AND WATER COMPANY

RESULTS OF VISUAL INSPECTION

APRIL 1979 PLATE B-1

SUSQUEHANNA RIVER BASIN

LAKE RUN, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE HENRY DAM

NDI ID No. PA-00366
DER ID No. 35-16

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

APRIL 1979

APPENDIX C

HYDROLOGY AND HYDRAULICS

APPENDIX C

HYDROLOGY AND HYDRAULICS

In the recommended Guidelines for Safety Inspection of Dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended Spillway Design Flood (SDF) for the size (small, intermediate, or large) and hazard potential (low, significant, or high) classification of a dam is selected in accordance with the criteria. The SDF for those dams in the high hazard category varies between one-half of the Probable Maximum Flood (PMF) and the PMF. If the dam and spillway are not capable of passing the SDF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, or if the dam is not in the high hazard category, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

APPENDIX C

SUSQUEHANNA River Basin

Name of Stream: LAKE RUN

Name of Dam: LAKE HENRY

NDI ID No.: PA-00366

DER ID No.: 35-16

Latitude: N 41° 17' 05" Longitude: W 75° 29' 20"

Top of Dam (~~low spot~~ DESIGN) Elevation: 1908.3

Streambed Elevation: 1896.0± Height of Dam: 12 ft

Reservoir Storage at Top of Dam Elevation: 811 acre-ft

Size Category: SMALL

Hazard Category: HIGH (see Section 5)

Spillway Design Flood: PMF - BECAUSE HIGHLY POPULATED TOWN OF MOSCOW DOWNSTREAM.

UPSTREAM DAMS

Name	Distance from Dam (miles)	Height (ft)	Storage at top of Dam Elevation (acre-ft)	Remarks
NONE				

DOWNSTREAM DAMS

ELMHURST		64	3744	HIGH HAZARD - SPILLWAY INADEQUATE
ALSO				NDI PA-00296
HOLLISTER DAM - BREACHED				

SUSQUEHANNA River Basin

Name of Stream: LAKE KUN

Name of Dam: LAKE HENRY

NDI ID No.: PA-00366

DER ID No.: 35-16

Latitude: N 41° 17' 05" Longitude: W 75° 29' 20"

DETERMINATION OF PMF RAINFALL

For Area A

which consists of Subareas A1 of 0.3 sq. mile

Total Drainage Area 0.3 sq. mile

PMF Rainfall Index = 22.15 in., 24 hr., 200 sq. mile

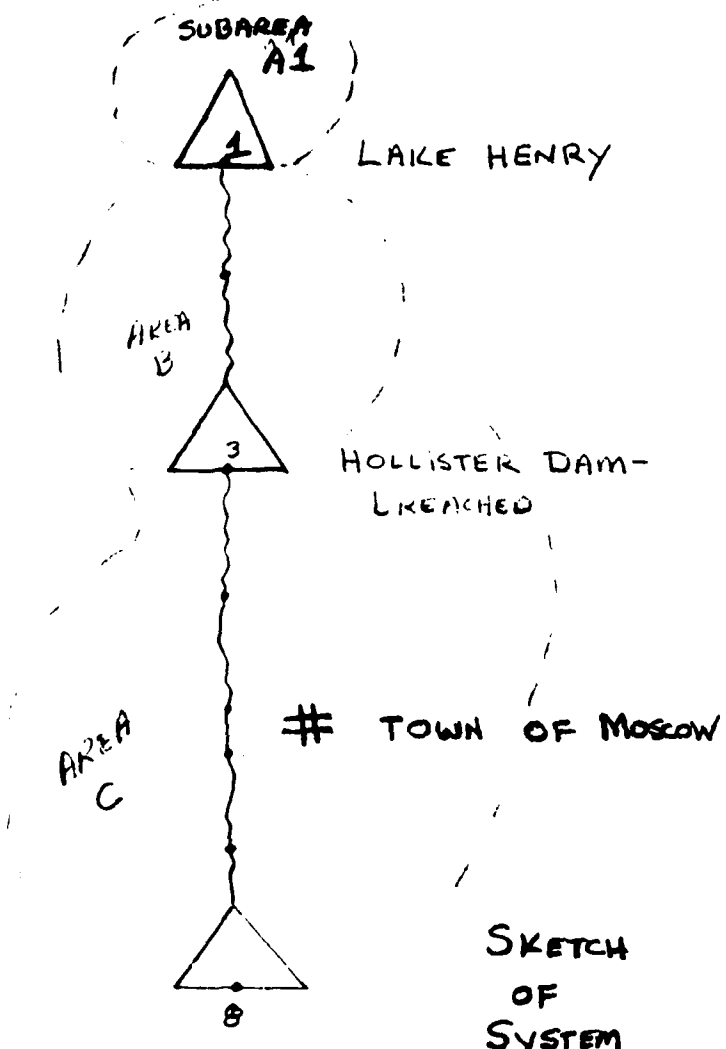
	Hydromet. 40 (Susquehanna Basin)	Hydromet. 33 (Other Basins)
Zone	N/A	N/A
Geographic Adjustment Factor	97%	1.0
Revised Index Rainfall	21.5	N/A

RAINFALL DISTRIBUTION (percent)

Time	Percent
6 hours	118
12 hours	127
24 hours	136
48 hours	142
72 hours	145
96 hours	N/A

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT _____ FILE NO. _____
SHEET NO. _____ OF _____ SHEETS
FOR _____
COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____



SKETCH OF SYSTEM

NOTE: ELMHURST DAM

AREAS B AND C NOT INCLUDED IN COMPUTER ANALYSIS

6313

Data for Dam at Outlet of Subarea A1
(see Sketch on Sheet C-4)

Name of Dam: LAKE HENRY Sheet 1 of ___

Height: 12 FT ~~(existing)~~

Spillway Data:	Existing Conditions	Design Conditions
Top of Dam Elevation	1907.6	1908.3
Spillway Crest Elevation	1905.8	1905.8
Spillway Head Available (ft)	1.8	2.5
Type Spillway	INCLINED MASONRY WEIR	
"C" Value - Spillway	3.1	3.1
Crest Length - Spillway (ft)	27.2	27.2*
Spillway Peak Discharge (cfs)	204	333
Auxiliary Spillway Crest Elevation	SEE NEXT SHEETS	
Auxiliary Spillway Head Available (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spillway		
Crest Length - Auxiliary Spillway (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

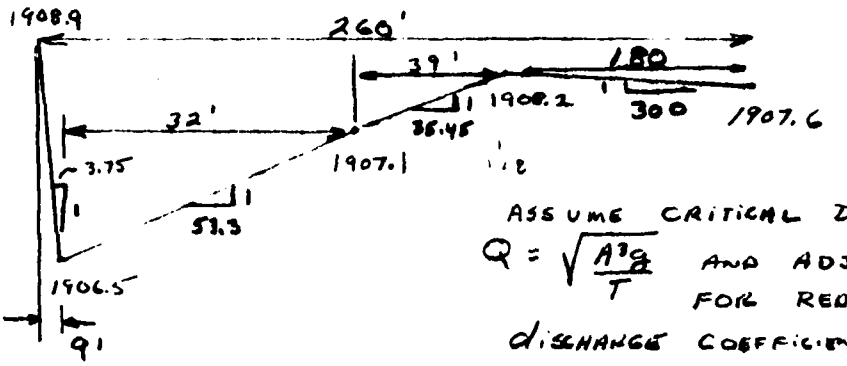
Spillway Rating Curve: * DRAWINGS SHOW GREATER WIDTH

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
	SEE SHEET C-7		

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT _____ FILE NO. _____
SHEET NO. _____ OF _____ SHEETS
FOR _____
COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____

Low Area between Embankments



Assume critical depth $Q = \sqrt{\frac{A^3 g}{T}}$ and adjust for reduced discharge coefficient by factor $\frac{2.7}{3.1}$

Find pool elevation by adding velocity head to water surface

$hv = V^2/2g$ $V = Q/A$

Water surface	Area Increment	Area Total	Topwidth Incr.	Topwidth Total	$\frac{2.7}{3.1}\sqrt{\frac{A^3 g}{T}}$	hv	Pool elev
1906.5	0	0			0	0	1906.5
	7.13		28.5				
1907.0		7.13		28.5	18	.1	1907.10
	8.14		–				
1907.1		10.27 ✓		34.3 ✓	28	.1	1907.20
	16.9		15.8				
1907.5		27.15		50.1	99	.2	1907.7
	5.21		3.9				
1907.6		32.4		54.0	124	.2	1907.8
1908.2		124.58		257.3	428.	.2	1908.4
1910.0		590.15		260	4393	.9	1910.9

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GANNETT FLEMING CORDDRY
AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT _____ FILE NO. _____

SHEET NO. ____ OF ____ SHEETS

FOR _____

COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____

MAIN spillway $Q = 3.1 \times 27.2 \times H^{1.5}$

$H = (\text{POOL EL} - 1905.8)$

POOL EL	Q AUX SPILL	Q MAIN spillway	ΣQ
<——— PREVIOUS SHEET ——→			
1905.8	—	0	0
1906.5	—	49	49
1907.1	18	125	143
1907.2	28	140	168
1907.7	99	221	320
1907.8	124	238	362
1908.4	428	354	782
1910.9	4393	971	5364

LOW AREA BETWEEN EMBANKMENTS

OUTFLOW RATING CURVE

6313

Data for Dam at Outlet of Subarea A1

Name of Dam: LAKE HENRY Sheet 2 of __

Outlet Works Rating:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	1889.7		
Invert of Inlet	1891.4		
Type	CIP		
Diameter (ft) = D	2' = 24"		
Length (ft) = L	200		
Area (sq. ft) = A	3.14		
N	.014		
K Entrance	0.5		
K Exit	1.0		
K Friction* $= 29.1_N{}^2L/R^{4/3}$	2.87		
Sum of K	4.37		
$(1/K)^{0.5} = C$	.48		
Maximum Head (ft) = HM	17.6		
$Q = C\,A\,\sqrt{2g(HM)}$ (cfs)	51		
Q Combined (cfs)	≈50		

* R = Hydraulic Radius = (Area/Wetted Perimeter) = D/4 for Circular Conduits.

Data for Dam at Outlet of Subarea A1

Name of Dam: LAKE HENRY Sheet 3 of ___

Storage Data:

Elevation	Area (acres)	Storage million gals	Storage acre-ft	Remarks
1878.6 = ELEVO*	0	0	0	
1891.4 ~~= ELEV1~~	15.4† ~~= A1~~		65 ~~= S1~~	INTAKE INVERT ASSUMED NATURAL LAKE NORMAL POOL
1901.1	47.5†		356	OLD DAM
1905.8 = ELEV1	69.4 = A1	204.927	628.9 = S1	
1908.3	76.3†		811	INTERPOLATED
1920 **	113			

† = INTERPOLLATED

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at ~~Top of Dam~~ Normal Pool Is 35 percent of watershed.

Remarks: ___

SUSQUEHANNA River Basin

Name of Stream: LAKE RUN

Name of Dam: LAKE HENRY

~~NDS ID No.:~~ _____

~~DER ID No.:~~ _____

Latitude: N 41° 17' 05" Longitude: W 75° 29' 20"

Drainage Area: 0.3 sq. mile

Data for Subarea: A1 (see Sketch on Sheet C-4)

Name of Dam at Outlet of Subarea: LAKE HENRY

Drainage Area of Subarea: 0.3 sq. mile

Subarea Characteristics:

Assumed Losses: 1.0-inch initial abstraction + 0.05 in/hr

The following are measured from outlet of subarea to the point noted:

L = Length of Main Watercourse extended to the divide = 0.91 mile

L_{CA} = Length of Main Watercourse to the centroid = 0.42 mile

From NAB Data: AREA 11 PLATE E

Cp = 0.62

C_T = 1.50

Centroid located in Reservoir → Length Reservoir to Divide = 0.38 mi = L' → $Tp = C_T (L')^{0.6}$

$Tp = C_T \times (L \times L_{CA})^{0.3}$ = 1.12 (hrs) = 0.84 HRS USED

Flow at Start of Storm = 1.5 cfs/sq. mile x Subarea D.A = 0.5 cfs

Computer Data:

QRCSN = -0.05 (5% of peak flow)

RTIOR = 2.0

Remarks: _____

SELECTED COMPUTER OUTPUT

ITEM	PAGE
INPUT	C-12
SUMMARY OF PEAK FLOWS	C-13
LAKE HENRY DAM	C-14

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 197X
  LAST MODIFICATION  26 FEB 79
**********************************
    1                 A1                                NATIONAL DAM INSPECTION PROGRAM
    2                 A2                                        LAKE RUN
    3                 A3                                   LAKE HENRY DAM
    4                 B     300          9        15         0         0         0         0         0        -4         0
    5                 C1      5
    6                 J       1          4         1
    7                 J1      1         .7        .6        .5
    8                 K                  1                                                  1
    9                 K1          RUNOFF INTO LAKE HENRY
   10                 M       1          1       0.3                 0.3                                      1
   11                 P                 21.       115       127       136       142       145
   12                 T                                                                   1.0       .05                 .35
   13                 W      .84        .6
   14                 X    -1.5       -0.05       2.0
   15                 K       1          1                                                  1
   16                 K1          ROUTE THROUGH LAKE HENRY
   17                 Y                                      1
   18                 Y1      1                                                                 -1905.8        -1
   19                 Y41905.8   1906.3    1907.1    1907.2    1907.7    1907.8    1908.4    1910.9
   20                 Y5      0         4?       143       168       320       362       782      5364
   21                 YA      0       69.2       113
   22                 SE1878.6   1905.2    1920
   23                 *S1905.8
   24                 SD1907.6
   25                 QL      1        360      1220      1773      1773
   26                 QV1907.6   1907.7    1907.9    1908.3    1920
   27                 E       00
```

C-12

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS			
				RATIO 1	RATIO 2	RATIO 3	RATIO 4
				1.00	.70	.60	.50
HYDROGRAPH AT	1	.30	1	1191.	834.	715.	596.
	(	.78)	(	33.74)(	23.62)(	20.24)(	16.87)(
ROUTED TO	1	.30	1	944.	406.	289.	221.
	(	.78)	(	26.74)(	11.50)(	8.19)(	6.26)(

SUMMARY OF DAM SAFETY ANALYSIS

LAKE HENRY DAM

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
EL MSL	1905.60	1905.80	1907.60
STOR	629.	629.	759.
AREA	0.	0.	290.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1907.99	.39	788.	944.	3.75	41.00	0.00
.70	1907.77	.17	771.	406.	2.50	42.00	0.00
.60	1907.66	0.06	758.	289.	0.00	42.50	0.00
.50	1907.37	0.00	742.	221.	0.00	42.50	0.00

C-14

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT _____ FILE NO. _____
_____ SHEET NO. ____ OF ____ SHEETS
FOR _____
COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____

SUMMARY OF PERTINENT RESULTS
(DAM WITH EXISTING CONDITIONS)

PMF RAINFALL = 24.9"

	PMF	½ PMF
RUNOFF (INCHES)	23.3	11.6
LAKE HENRY DAM		
INFLOW (CFS)	1191	596
OUTFLOW (CFS)	944	221
DEPTH OF OVERTOPPING (FT.)	0.39	—

6913

SUSQUEHANNA RIVER BASIN

LAKE RUN, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE HENRY DAM

NDI ID No. PA-00366
DER ID No. 35-16

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

APRIL 1979

APPENDIX D

PHOTOGRAPHS

A. Upstream Slope - Right Embankment

B. Outlet Works Outfall

C. Left Embankment - View from Right End

D. Low Area Between Embankments

E. Spillway Approach

F. Spillway

SUSQUEHANNA RIVER BASIN

LAKE RUN, LACKAWANNA COUNTY

PENNSYLVANIA

LAKE HENRY DAM

NDI ID No. PA-00366
DER ID No. 35-16

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

APRIL 1979

APPENDIX E

GEOLOGY

LAKE HENRY DAM

APPENDIX E

GEOLOGY

1. General Geology. The damsite and reservoir are located in Lackawanna County. Lackawanna County was completely covered with ice during the last continental glaciation of Pleistocene time. The general direction of ice movement was S 35° - 40° W. Glacial drift covers the entire County, except where subsequent erosion has removed it. Thick deposits of glacial outwash occur in many places along the Lackawanna River, and are 50 to 100 feet thick near Dickson, Scranton, and Moosic.

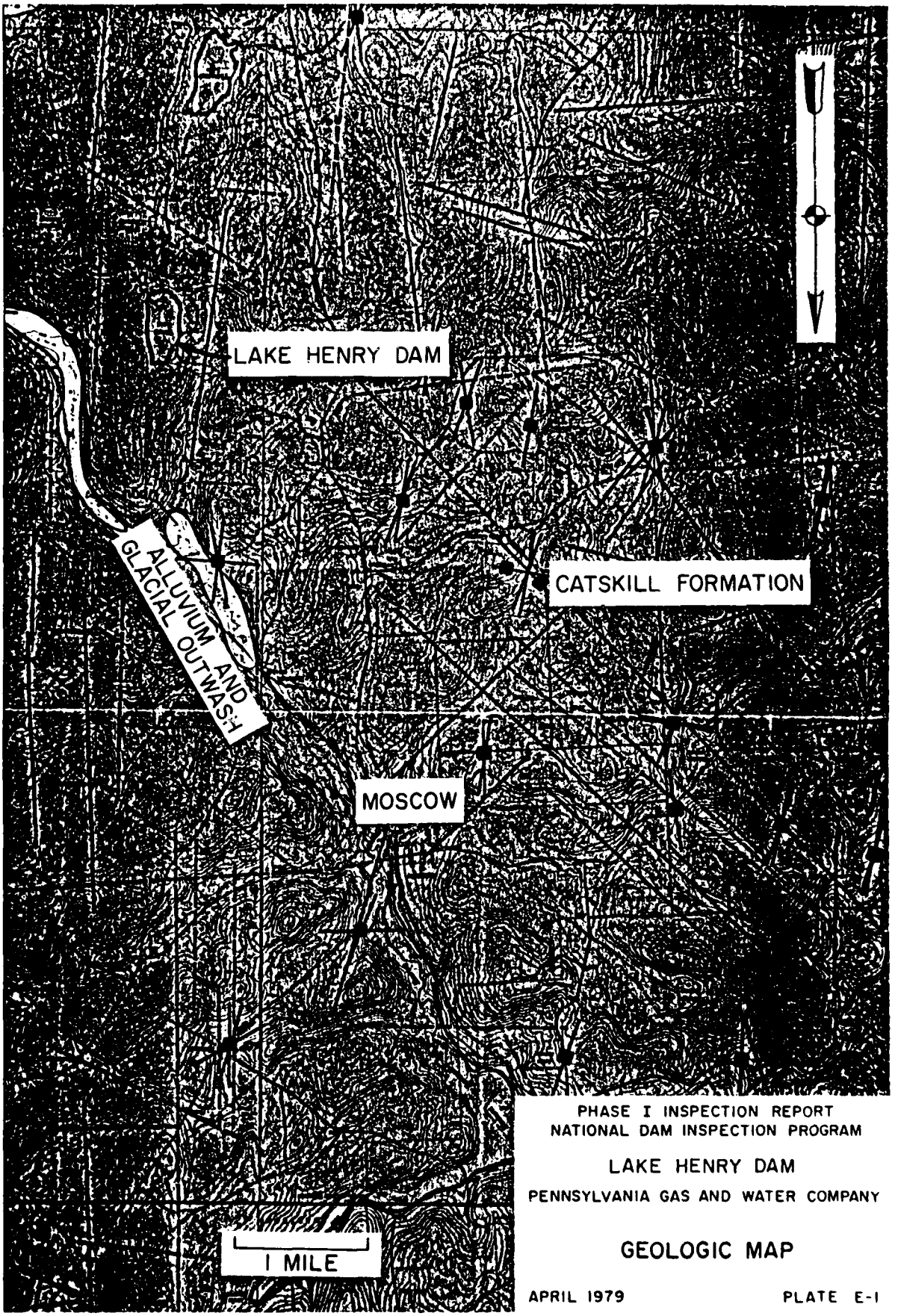
The only important structural feature in Lackawanna County is the Lackawanna Syncline, which traverses the County in a southwesterly direction. The syncline enters the County at the northeast corner as a narrow shallow trough, gradually deepens and broadens toward the southwest, and reaches its maximum development in Luzerne County. The rock formations exposed range from the post-Pottsville formations (youngest) through the Pottsville, Mauch Chunk shale, Pocono sandstone to the Damascus formation of the Catskill group (oldest). The rim rocks, the Pottsville formation and Pocono sandstone, have dips that rarely exceed 10° to 20° and form rather simple syncline. The core rocks, the post-Pottsville formations, are folded into a series of minor anticlines and synclines which trend about N 70° E. The rocks in the northwestern and southeastern parts of the County, outside of the limits of the Lackawanna Syncline, are generally horizontally stratified.

The Lackawanna River, in general, follows the axis of the Lackawanna Syncline. Southeast of the Lackawanna River, the rise in terrain is quite gradual and the crests of the high mountains are several miles from the Lackawanna River. Streams, such as Roaring Brook, Stafford Meadow Brock, and Spring Brook, have cut deep canyons through the mountains and follow a torturous course to their confluence with the Lackawanna River near Scranton. Northwest of the Lackawanna River, the mountains rise abruptly to a sharp ridge which in most places is somewhat higher than the country to the northwest. Consequently, most of the drainage in this part of the County flows westward by way of Tunkhannock

Creek. A few small tributary streams, however, such as Leggetts Creek, flow eastward from this area into Lackawanna River. In the area of interest, the Lackawanna River streambed is founded in post-Pottsville formations. Proceeding uphill from the river, the older Pottsville formation, Mauch Chunk shale, Pocono sandstone, and Catskill continental group are encountered in turn. The tributary streams, in flowing down the mountains, have generally cut through or around the hard sandstone and conglomerate members, and have eroded their streambed into the softer shales and glacial till. The Catskill continental group of rocks underlies the greater part of Lackawanna County.

2. Site Geology. Lake Henry Dam is underlain by the Catskill Formation of late Devonian Age on the Pocono Plateau. The plateau in this area is of very moderate local relief with many swamps and some peat bogs present. The Catskill Formation is composed of dark red shale, claystone and siltstone; gray, fine to medium grained sandstone, and coarse grained conglomerates. Crossbedding, channeling and cut-and-fill features are common to the sandstone and conglomerate units. Siltstone predominates in the lower part of the formation.

The Pennsylvania Water Supply Commission, in their 1914 Report on the dam, considered the information about the dam unreliable. It was reported that the masonry core-wall was founded on a stratified sandstone for a portion of its length and on a clay for the remainder.



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE HENRY DAM

PENNSYLVANIA GAS AND WATER COMPANY

GEOLOGIC MAP

APRIL 1979

PLATE E-1